

10011139-1

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

**Patent Application for:**

**METHOD AND SYSTEM FOR IMPROVED MONITORING, MEASUREMENT  
AND ANALYSIS OF COMMUNICATION NETWORKS UTILIZING  
DYNAMICALLY AND REMOTELY CONFIGURABLE PROBES**

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**Docket Number:** 10011139-1

20047244 042400T

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3 **METHOD AND SYSTEM FOR IMPROVED MONITORING, MEASUREMENT**  
4 **AND ANALYSIS OF COMMUNICATION NETWORKS UTILIZING**  
5 **DYNAMICALLY AND REMOTELY CONFIGURABLE PROBES**  
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7

8 TECHNICAL FIELD  
9

10 This invention relates generally to the field of communication networks,  
11 and more specifically to a system and method for monitoring and improving  
12 communication networks, including telecommunication and wireless networks.  
13

14 BACKGROUND OF THE INVENTION

15 The advent and rapid expansion of communication networks in which mobile  
16 communication devices are installed, such as wireless cellular telephone  
17 networks, have placed ever-increasing demands on the network operator to  
18 maintain and improve network quality. To this end, service providers and  
19 other network operators have typically deployed a dedicated Mobile Test Unit  
20 (MTU) measurement tool in the network as needed to perform field  
21 measurements in response to consumer complaints and other indicators of  
22 poor network quality. The MTU is a dedicated hardware test solution  
23 deployed on a limited basis to collect measurement data and the number of  
24 units deployed is very small in relation to the subscriber population, yielding a  
25 statistically small measurement base.  
26

27 The problems associated with the collection of network field measurements in

1 this way are many. Since the MTU or equivalent is a statistically small  
2 sampling of the actual population of users at any given time, the collected  
3 data may be statistically suspect on a day-to-day operational basis. The  
4 collection of measurement data does not necessarily reflect the occurrence of  
5 problems as experienced by an actual user of the network since the  
6 deployment of the test units are so sparse relative to the device population. In  
7 other words, the MTU may not actual "see" the problem as it is seen by an  
8 actual user on the network. Moreover, the deployment of MTUs in an indoor  
9 environment is performed in a very limited, diagnostic way, thereby yielding  
10 statistically insignificant sampling in that environment. Statistical switch  
11 information has been used to try to provide broader statistical sampling that  
12 more closely approximates the number of subscriber units. However, the  
13 amount of detail provided is often compromised when the network is  
14 experiencing significant network problems. Also, collection of data at the  
15 switch does not necessarily reflect the actual experience of individual network  
16 users.

17  
18 There is therefore an unmet need in the art to be able to quickly, accurately,  
19 and dynamically respond to perceived quality problems occurring within  
20 communication networks, in both indoor and outdoor environments, with  
21 broad statistical sampling in order to be able to enhance quality of network  
22 services perceived by individual network users.

#### 23 24 SUMMARY OF THE INVENTION

25  
26 Therefore, in accordance with the present invention, one or more  
27 communication devices within a communication network are provided with a  
28 dynamically and remotely configurable probe element, implemented at least  
29 partially in software and controllable by the network operator via one or more



1 communication links, capable of monitoring, measuring and capturing user  
 2 interaction data flowing from voice and/or data transactions occurring in the  
 3 network. User interaction data reflects a user's actual experience on the  
 4 network and thus provides valuable raw data usable by the network operator  
 5 for improving network quality from the user's perspective, especially when  
 6 received from a statistically significant number of network user devices.  
 7 Collected user interaction data can include network engineering metric data  
 8 and/or user profile data.

10  
 11 BRIEF DESCRIPTION OF THE DRAWINGS

12  
 13 The features of the invention believed to be novel are set forth with  
 14 particularity in the appended claims. The invention itself however, both as to  
 15 organization and method of operation, together with objects and advantages  
 16 thereof, may be best understood by reference to the following detailed  
 17 description of the invention, which describes certain exemplary embodiments  
 18 of the invention, taken in conjunction with the accompanying drawings in  
 19 which:

20  
 21 **FIG. 1** is a block diagram of a communication network having one or  
 22 more configurable software probes in communication devices of the  
 23 network, according to an embodiment of the present invention.

24  
 25 **FIG. 2** is a block diagram of an exemplary wireless communication  
 26 network, according to an embodiment of the present invention.

27  
 28 **FIG. 3** is a flow chart in accordance with an embodiment of the  
 29 methodology of the present invention.

1  
2 **FIG. 4** is a flow chart in accordance with a further embodiment of the  
3 methodology of the present invention.  
4

5  
6 DETAILED DESCRIPTION OF THE INVENTION  
7

8 While this invention is susceptible of embodiment in many different forms,  
9 there is shown in the drawings and will herein be described in detail specific  
10 embodiments, with the understanding that the present disclosure is to be  
11 considered as an example of the principles of the invention and not intended  
12 to limit the invention to the specific embodiments shown and described. In the  
13 description below, like reference numerals are used to describe the same,  
14 similar or corresponding parts in the several views of the drawings.  
15

16 The present invention describes software capable of monitoring, capturing  
17 and measuring actual network experience from the perspective of a  
18 communication device in a communication network, such as from the  
19 perspective of a wireless handset in a wireless communication network, in  
20 order to provide actual, empirical information like Quality of Service (QoS)  
21 from the perspective of a user of the communication device. This actual  
22 network data provides valuable information that can be used by an operator of  
23 a network to improve the quality of the network, particularly with regard to the  
24 quality of service as perceived from the perspective of a user of a particular  
25 communication device. For instance, a wireless service provider (WSP), such  
26 as a cellular phone service provider or other network operator of a  
27 communication network, can use the captured data from various  
28 communication devices on its wireless network to analyze, identify and  
29 subsequently improve problem areas in delivery of services, thereby

1 improving the quality of the network as perceived by users of the network. As  
2 used herein, the term network operator may, in addition to being a service  
3 provider, encompass other definitions of control and/or interest in the  
4 workings of the communication network, such as a manufacturer of a  
5 communication device and third party companies other than the actual service  
6 provider, like those providing consulting services to a service provider.

7

8 Referring now to **FIG. 1**, a system block diagram of a system 100 in  
9 accordance with the present invention is shown. A number of unattended  
10 communication devices 110, capable of having a software probe element and  
11 thus functioning as unattended probes, are operable to function in  
12 communications network 190. Communication network 190 is capable of  
13 providing or facilitating voice communication and/or data transactions,  
14 services, or communications. Examples of communication networks in which  
15 the present invention may be practiced include, but are not limited to,  
16 telecommunication networks, wireless networks, telephone networks, such as  
17 cellular mobile telephone networks (CeN), and data communication networks.  
18 A communication device 110 may be any device having a user interface  
19 capability associated with it, a network connectivity capability, the ability to  
20 receive location-based services and, preferably, the ability to accept software  
21 applications such as the software probe application of the present invention.  
22 Examples of communication devices include, but are not limited to, wireless  
23 communication devices such as a handsets or cellular telephones, telematics  
24 devices or modules (such GM's OnStar System), personal computers (PCs),  
25 consumer appliances such as set-top boxes, and personal digital assistants  
26 (PDAs).

27

28 As will be described, communication devices 110 having a configurable probe  
29 element 160 are able to monitor, measure and capture transactions occurring

1 in the network, as seen from the perspective of a user of the communication  
2 device, and then provide this user interaction data via one or more  
3 communication links 180 to one or more servers 195 of the network 190. This  
4 user interaction data may be either network engineering metric data or user  
5 profile data and is important to optimizing the functionality and quality of the  
6 network as seen by the user of the communication device. Operation and  
7 quality of the network is managed by a network operator. Transaction data  
8 and user interaction data measured and collected from the user/network  
9 transactions can be temporarily stored in a memory 150 of the communication  
10 device prior to being transmitted via the communication link 180 to the  
11 network server 195. The one or more communication links to the network  
12 may be any means suitable for communicating between the communication  
13 device and the rest of the communications network 190 and thus include, by  
14 way of example and not limitation, wireless, cable, fiber optics, Internet, virtual  
15 private network (VPN) tunneling, etc. For instance, the link may be an  
16 Internet link to a public or private network server or it may be a private  
17 network medium to a private network, as in the case of a virtual private  
18 network (VPN) tunnel to a server residing at a corporate intranet site or it may  
19 be an HTTP connection via the Internet to the server 195. The measurement  
20 values of the user interface data may be in CSV (comma separated values)  
21 format passed in an HTTP POST parameter list, for instance. The user  
22 interaction data may or may not be encrypted; encryption may be necessary  
23 in environments in which user and data privacy is a concern. Many known  
24 encryption techniques and approaches, such as the MD5 hashing algorithm,  
25 may be utilized.

26  
27 The functionality of the server may include the ability to store user interface  
28 data transmitted from the communication device to the server via the  
29 communication link and the ability to send desired diagnostic criterion to be



1 performed by the software probe of one or more communication devices. The  
 2 server 195 may be one or more servers having functionality to remotely  
 3 control software probe 160 and may serve as one or more databases for  
 4 storing the user interaction data collected from the various communication  
 5 devices 110. For instance, the user interaction data may be stored in one or  
 6 more database tables via SQL on an Oracle 8i database.

7  
 8 The communication device will preferably have a transceiver element 130  
 9 having both receiver and transmitter functionality for facilitating  
 10 communications between the communication device and the communication  
 11 network 190; a controller and processing capability, such as embedded JAVA  
 12 processing, which, together, can be referred to as a control and processing  
 13 element 170; a user interface element 140, such as a keypad and display  
 14 screen to allow the user to both send and receive communications and  
 15 transactions in the network via the communication device; a dynamically and  
 16 remotely configurable probe element 160 representative of the software probe  
 17 described above; and a memory element 150, such as a buffer, for storing, at  
 18 least temporarily, transaction data that is monitored, measured and captured  
 19 by the communication device prior to it being transmitted to a server 195 of  
 20 network 190. The user interface element will have the ability to monitor key  
 21 presses made by the user, recognize voice activity of the user, and the ability  
 22 to create a data file of the actual user experience on the communication  
 23 device. The available memory resident in network communication devices is  
 24 growing rapidly and thus supports the temporary storage of user interaction  
 25 data prior to transmission of said data to a server of the network; handsets, for  
 26 instance, are expected to achieve 32-256 MBytes of memory.

27  
 28 Communications engaged in by a user of the communication device may be  
 29 manifested as voice and/or data transactions between the user and the

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1 communication network via the user interface 140. The probe element 160 is  
 2 a dynamically and remotely configurable software element that is able to  
 3 monitor, measure and capture at least some portion of the characteristics of  
 4 the transactions the user engages in, from the perspective of the user, as user  
 5 interface data. The functionality of the software probe 160 is performed in  
 6 accordance with a functional definition of the probe element that is able to be  
 7 dynamically and remotely configured, added to, changed, deleted, upgraded,  
 8 etc. at will via the one or more communication links 180 by the network  
 9 operator or other party interested in controlling probe operation of the  
 10 communication device. User interaction data collected by the configurable  
 11 software probe may be temporarily stored in memory 150. Control and  
 12 processing element 170 provides the control of the other elements and the  
 13 processing capability required by software 160.

14  
 15 The communication devices 110 communicate within the network 190 via one  
 16 or more communication links 180. While each communication device having  
 17 the software probe capability may communicate its user interaction data to a  
 18 server 195 on the network directly, it is also possible to perform some  
 19 measure of aggregation of user interaction data on the communication device  
 20 side of the network. To this end, communications capability between  
 21 communication devices in the network would allow a group of communication  
 22 devices within a certain geographical area, for instance, to transmit or route  
 23 their user interaction data to a collection communication device within the  
 24 group that would aggregate this user interaction data from the multiple  
 25 communication devices of the group prior to transmitting it across a  
 26 communication link to the network server. This would reduce the number of  
 27 direct communications occurring across the communication link to the network  
 28 server. Thus, each communication device 110 having the software probe  
 29 capability is also capable of communicating its collected user interaction data

1 to a server 195 of the network 190 via a collection communication device  
2 which collects user interaction data from one or more other communication  
3 devices, such as within a certain geographical area, and sends the  
4 aggregated user interaction data to the server 195. The use of a collection  
5 communication device frees up other communication devices from the  
6 responsibility of sending their user interaction data directly. The dashed  
7 communication links shown between the communication devices 110 illustrate  
8 the option of intra-communication device communication. The advances  
9 associated with the data transmission rates in network communication  
10 devices facilitates the transmission of large amounts of meaningful data from  
11 the communication devices to the network server. The data transmission  
12 rates associated with so-called second generation (2G) applications are rather  
13 inefficient, with a typical maximum rate being perhaps 9.6 or 14.4 kBits per  
14 Second. The data rates associated with 3G applications are expected to  
15 increase by roughly an order of magnitude or more, such as to 80 to 144 kBits  
16 per Second, and to change from circuit-switched to packet-data, for instance.

17  
18 In addition to the concept of groups being used to aggregate user interaction  
19 data prior to sending the data to the network, the concept of grouped  
20 communication devices can be used to facilitate broadcasting information  
21 and/or instructions from the server to the communication devices. The  
22 network operator may decide to broadcast a new or changed functional  
23 definition to each communication device in a group of communication devices,  
24 rather than to each individual communication device of the group. The group  
25 could be a subset of communication devices in the network or it may be  
26 considered to be all of the devices, in which case the broadcast would be  
27 considered a global change. The new functional definition can have several  
28 different effects on operation of the communication devices within the group.  
29 The changed functional definition may simply change the programming of the

1 communication devices without changing their mode of operation (either has a  
2 monitor type communication device or a diagnostic type communication  
3 device as will be described below), change the diagnostic criterion of  
4 communication devices operating in the diagnostic mode, or change the mode  
5 of operation, such as from changing the functionality of the communication  
6 device from a monitoring type to a diagnostic type device, or vice versa. The  
7 functional definition may be broadcast to a collection communication device of  
8 the group which will then have the responsibility for distributing the new  
9 definition to other devices within the group.

10  
11 Each communication device 110 can be any type of communication device,  
12 including wireless devices and telematic modules or devices capable of  
13 operating in a communication network environment, receiving location-based  
14 information such as might be provided by GPS technology, and preferably  
15 capable of supporting third party (3P) applications that can be loaded onto the  
16 communication device. The dynamically and remotely configurable probe  
17 software of the present invention is an example of such a 3P application.  
18 Location-based information may be provided internally to the communication  
19 device such as internally-generated GPS or it may be a network-provided  
20 service available upon demand.

21  
22 The probe element 160 is preferably software capable of being easily and  
23 remotely configured and controlled (added, modified, changed) by a network  
24 operator of the communication network 190 via the communication link 180.  
25 The probe software may be considered a third party (3P) application capable  
26 of residing and operating within the communication device. The software of  
27 the probe element may be implemented in any desired format, but will  
28 preferably be implemented in an open-development environment that  
29 facilitates the development of portable 3P applications. Examples of

1 acceptable application and/or programming platforms and environments  
2 suitable for implementation of the probe element include, but are not limited  
3 to, the following: Sun JAVA (J2ME), C, C++, Qualcomm Binary Runtime  
4 Environment for Wireless (BREW) application environment, Microsoft Stinger,  
5 Symbian operating system, or proprietary third party operating system,  
6 environment, and/or programming language. The probe software, which can  
7 include diagnostic criterion for performing network diagnostics, can be  
8 downloaded from the network operator to the communication device via the  
9 communication link, such as over the Internet. The probe software will  
10 preferably have an identification element, such as a control or serial number,  
11 which can be used to associate a particular copy of the software with a  
12 particular network subscriber or communication device.

13  
14 Collection of user interaction data can be used to profile subscribers (users of  
15 the communication devices) on the network and to isolate network  
16 engineering problems. Network engineering data or metrics are useful to  
17 characterize network performance while user profile data are useful to  
18 categorize the behavior and/or preferences of subscriber users on the  
19 network. User interaction data as network engineering data or data services  
20 measurements can include, but is not limited to the following: the location of  
21 attempted calls, no service calls, blocked calls, network messages, dropped  
22 calls, good calls, data delay, data errors, power measurements, interference  
23 measurements, quality measurements (such as signal strength, bit error rate,  
24 and frame erasure rate, etc.), attempted handoffs, successful handoffs, failed  
25 handoffs, the presence of neighbors on the network, the time it takes for a call  
26 to be connected, characterization of a call as incoming or outgoing, data  
27 throughput and location measurements (including latitude, longitude,  
28 elevation, time, speed of vehicle in which device is located). User interaction  
29 data as user profile data can include, but is not limited to, the following types

1 of data: time of call, call duration, number of calls placed, number of times a  
2 particular number is called, called numbers, and the number of times a  
3 previously blocked call is reattempted.

4

5 The method and timing of collection of user interaction data for a particular  
6 communication device is controlled by the functional definition of the software  
7 of the probe element, which can be dynamically changed as desired, and is  
8 reflected in the mode of operation of the communication device, as will be  
9 discussed. Collection of data may be triggered by the occurrence of an event,  
10 such as the user turning on the handset or a dropped call, and either pre- or  
11 post-event collection is selectable for a predetermined period of time  
12 bracketing an event, such as 30 seconds within the occurrence of an event.

13 There may additionally be conditional collection of data such as circular and  
14 rectangular areas of collection within the network and interval collection  
15 dependent on various interval measurements such as time of day intervals  
16 and distance intervals. The collection of the user interaction data by the  
17 network can be supplied to various functions in the network, such as customer  
18 care, operations, engineering, maintenance, etc. for use in improvement  
19 network performance.

20

21 Consider the following example in which the monitoring and collection of user  
22 interaction data is illustrated. The specific measurements explored in this  
23 example of data and voice calls are by way of example only and are not  
24 meant to be limiting of the present invention. Position data (longitude,  
25 latitude, etc.) is collected at the point of original of call origin and an answered  
26 call by the software of the probe monitoring the SEND key or Voice Activity  
27 Detection (VAD) feature of the user interface of a subscriber wireless device.  
28 If no voice activity is detected for a default period, such as 20 Seconds or  
29 more, then the call is classified as a Blocked call. If voice activity is present

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1 but lasts only 15 Seconds before ending without an END key press, then the  
2 call is tagged as a Network Error Message. If the call has voice activity that  
3 last longer than 15 seconds and then ends without an END key press, then  
4 the call is classified as a Dropped call. Any calls that have voice activity, last  
5 longer than 15 seconds, and then end with an END key press, can be  
6 classified as a Good call. Any placed call that is placed while the phone is in  
7 a No Service State will be recorded as a No Service call.

8  
9 In addition to these call statistics, data statistics may be collected by  
10 additionally monitoring the microbrowser of the cellular phone, for instance,  
11 for that during user initiated data calls, the call throughput and delay for each  
12 data transaction as well as the overall time of the data call itself may be  
13 determined. Anytime that the measured throughput or delay is beyond an  
14 acceptable definable threshold, such as 15 seconds, then the call is classified  
15 as a Slow Data Response call. If a call was not successfully established, it  
16 could be designated a Failed Connection call. If an established data call is  
17 lost, then it could be classified as a Disconnected Data call. Data calls not  
18 having the above problems, may be classified as Good Data calls. The above  
19 provides an example of a time-based classification of transactions.

20  
21 The above call-processing and data service usage experiences of the user of  
22 the communication device constitute examples of user interaction data that  
23 can be temporary stored in a data file on the handset until such time as a file  
24 transfer to transfer the data to the network server can be performed. Exactly  
25 when the data will be uploaded is definable. An example of transmission  
26 would be include at the end of a subscriber's data call, the software remaining  
27 linked to the network for an additional 10 seconds and then transferring the  
28 file to the server in a manner transparent to the device user. Another example  
29 would be to send the data as a data call to the network right at power down of

1 the device. This could be accomplished by blanking the phone screen while  
2 still being powered on for an additional period of time, such as 30 seconds or  
3 less, to perform the file transfer at a predetermined time.

4  
5 Multiple communication devices, all with the capability to monitor and capture  
6 interaction of the communication devices with the communication network.  
7 Placement of the monitoring and capturing capability at the communication  
8 device greatly improves the quality of information and thus the performance  
9 statistics that can be gathered on network performance. Actual coverage of  
10 both the geographic area covered by the network and the device base may be  
11 obtained simultaneously through the monitoring and collection of individual  
12 device experiences in the network. Reliance on the previous practice of  
13 individual drive tests, in which estimations concerning network performance  
14 are extrapolated from a statistically insignificant number of tests and which  
15 provide much less reliable statistical information, may be greatly reduced.  
16 And, since the information gathered is from the perspective of multiple  
17 communication devices, there is a real, previously unavailable opportunity to  
18 improve the network user's experience.

19  
20 Placement of the monitoring and capture software probe inside a statistically  
21 significant number of the actual communication devices in the network is  
22 economically viable, especially when such probes are implemented in  
23 software as is the case in the preferred embodiment. The user interaction  
24 data transmitted from multiple communication devices in the network to the  
25 server may be aggregated to provide statistically significant information about  
26 either users on the network or about geo-centric network performance  
27 problems occurring within the network. The greater the number of  
28 communication devices in the network having the software probe, the better  
29 the statistical information, in terms of geographic and temporal coverage, that



1 can be gleaned about the network.

2

3 A communication device 110 having the configurable probe element 160 may  
4 operate in a variety of probe modes. Modes of operation of a communication  
5 device include, but are not limited to, a non-interactive mode of operation, a  
6 quasi-interactive mode of operation, and a diagnostic mode of operation. In  
7 the normal, non-interactive mode of operation, the communication device  
8 monitors and captures transactions between the user and the communication  
9 network, whether they be voice and/or data service transactions, such as a  
10 voice call or downloading E-mail, and measures characteristics of the  
11 transactions to generate the user interaction data in a manner that is  
12 transparent to the user of the communication device. The advantage to the  
13 user of this mode is that transactions between the user and the network may  
14 be monitored, captured and measured without affecting service in the network  
15 to the user. Control of the transmission of the user interaction data resides  
16 within the software probe configuration which can be changed or updated as  
17 desired and may be a function of the size of the temporary memory 150  
18 resident in the communication device. For example, the captured data may  
19 be updated via the communication link to the network server after every N  
20 calls and the memory or buffer of the communication device cleared out to  
21 make room for more data. The frequency of uploading data to the network  
22 may be increased if the available memory is otherwise insufficient.

23

24 In a quasi-interactive mode of operation, the communication device still  
25 monitors and captures user/network transactions experienced by the user and  
26 measures one or more characteristics of such transactions to generate the  
27 user interaction data, but the user is additionally given the option of deciding  
28 when to report to the network operator one or more network performance  
29 problems identified in the user interaction data. The probe software may

1 present the user with an option, in "real-time" at the time of occurrence of a  
2 network performance problem or event, of when to report the problem, such  
3 as immediately, or the user may be provided with this option at predetermined  
4 intervals, such as at X seconds following the occurrence of the network  
5 problem. Alternately, the user may have previously selected that the  
6 communication device would operate in this mode of operation.

7  
8 Consider the following example of operation of the communication device in  
9 the quasi-interactive mode of operation. Upon the occurrence of the network  
10 event of a cellular telephone user's call being dropped, the software probe  
11 resident on the device, which has monitored and thus captured the event,  
12 communicates with the user via a GUI, for instance, to ask if the user would  
13 like to "opt-in" to report the problem to customer care of the network service  
14 provider. If yes is selected, then the user is next given the option of when to  
15 report the network problem: Now, Later, or Automatically. If the user selects  
16 the Now option, the software probe causes the phone to transmit the data  
17 associated with this problem to the network server immediately. If the user  
18 selects to report the problem the Automatic option, then the probe software  
19 arranges to report the problem at a predetermined time (such as every 30  
20 minutes) or upon occurrence of a predetermined event (such as upon the user  
21 powering-down the phone) without further input from the user. If the user  
22 selects to report the problem Later, then this will cause the data associated  
23 with the problem to be transmitted by the phone to the network server at some  
24 future, predetermined time. Optionally, the software probe may cause  
25 another option to be presented to the user if the same network problem or  
26 event occurs a predetermined number of times, such as more than three, to  
27 never report the problem to the network. Selection of the Never option by the  
28 user may have the effect of de-installing the probe software from the user's  
29 communication device. This example makes it clear that it takes less effort on

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1 the part of the user to report network problems or events to the network  
2 operator. More accurate information can only help to improve the quality of  
3 services that is provided to network clients.

4  
5 In the diagnostic mode of operation, the network operator, such as the service  
6 provider, is permitted to dynamically control the communication device in  
7 accordance with a diagnostic criterion, which may be one or more diagnostic  
8 tests that the communication device is to perform in order to diagnose one or  
9 more network performance problems that have been identified in the network.

10 This mode provides a dynamic analysis and troubleshooting capability to the  
11 network operator without the need to send drive units into the network and  
12 thus the quality of service as perceived by the user can be more readily and  
13 quickly improved at a much lower overall cost. In the diagnostic mode of  
14 operation, classification of transactions occurring may be message-sequence  
15 based as well as a time-based approach. For instance, further call  
16 classification may be based upon message-based algorithms in which greater  
17 resolution of classification types may be achieved to further improve the  
18 diagnostic capabilities.

19  
20 The diagnostic criterion may be downloaded as needed from the network  
21 operator to the probe software via the communication link existing between  
22 the network and the communication device. The diagnostic criterion may be  
23 changed, updated, deleted, or added in real-time by the network operator as  
24 needed via the communication link. For instance, a version of the software  
25 probe in the communication device may have a "time bomb" feature in which  
26 the software is automatically de-installed after a certain period of time or upon  
27 the occurrence of a particular event. This feature may prompt the software to  
28 request an updated version of the software from the network operator via the  
29 communication link.

1

2 Entry into the diagnostic mode may be achieved a number of ways. Entry  
3 may be controlled by the network operator in response to the need at the  
4 network level to perform diagnostics in a geographical or temporal area in  
5 which the communication device happens to be located. For instance, the  
6 network operator may send updated diagnostic programming designed to test  
7 certain network problems to a communication device in response to that  
8 device entering the geographical area having those network problems. In  
9 instances in which the network operator, such as a customer care or  
10 engineering function of a network service provider, assumes operational  
11 control of the communication device, the user of the communication device  
12 may have previously given permission for the network to dynamically assume  
13 control of its communication device in certain situations, such as in return for  
14 a lower monthly subscriber rate or as part of a subscriber contract. Assumed  
15 control of the communication device by the network operator, however, is  
16 accomplished in a manner that preferably minimizes disruption in service to  
17 the subscriber user. The user will be allowed to resume control of the  
18 communication device at any time an emergency number, such as 9-1-1, is  
19 dialed, for instance. In addition to the diagnosis mode of operation be  
20 effected by the network operator, entry in real-time may also be accomplished  
21 at the request or instigation of the user of the device. Consider the user  
22 requesting that the network perform a diagnosis of or validate the user's  
23 handset.

24

25 When the communication device is not in the diagnostic mode, the  
26 communication device may otherwise operate in the non-interactive mode in a  
27 manner that is transparent to the user as outlined above. Alternately, the  
28 communication device may operate in a quasi-interactive mode, outlined  
29 above, in which the user is given the opportunity to decide when to report one

1 or more network performance problems that have been identified.

2

3 Referring now to **FIG. 2**, a system block diagram 200 of an exemplary  
4 wireless communication network environment in accordance with a preferred  
5 embodiment of the present invention is shown. A number of unattended  
6 communication device probes 110 are illustrated. While these communication  
7 devices are illustrated as cellular telephones, it is understood that any desired  
8 communication device may be used, as described above. Each of the  
9 communication devices 110 may have resident probe software making it  
10 capable of monitoring and capturing and making measurements of  
11 transactions occurring between a user of the communication device and the  
12 communication network to generate user interaction data associated with the  
13 particular communication device 110. The communication device 110 can  
14 then transmit its data to one or more servers 195 of the communication  
15 network via one or more communication links 210, 220, 230, 250, etc. In this  
16 cellular telephone network example, the communication devices 110 transmit  
17 user interaction data using UDP or SMS packets to a base station 210 and  
18 circuit switch or packet network 220 which in turn can transmit the user  
19 interaction data to the one or more servers 195 in a variety of ways, such as  
20 via a VPN tunnel communication link 230 to a private intranet environment  
21 240 or via a communication link like the Internet 250 to another network, such  
22 as a corporate network. As previously described, each of the communication  
23 devices 110 may send their own collected user interaction data to servers of  
24 the network directly or they may be in communication with another  
25 communication device of the network that serves as a collection  
26 communication device. The collection communication device is responsible  
27 for collecting and then aggregating user interaction data from multiple  
28 communication devices prior to sending the aggregate user interaction data to  
29 one or more servers of the communication network via the appropriate

communication link(s). The user interaction data provided to the one or more servers 195 of the network, whether aggregated or not, provide the important raw data needed to analyze network conditions and identify potential problem areas on the network.

FIGs. 3-4 illustrate one or more aspects of the methodology associated with the software probe of the present invention. These aspects have been discussed in more detail previously.

Referring now to FIG. 3, flowchart 300 illustrates the methodology of the present invention from the perspective of the software probe on a communication device. At Block 310, the software causes transactions between the communication device and the network to be monitored according to the functional definition of the probe software. The functional definition can be down-loaded from the network operator of the network as needed in real-time, may be changed as required, or it may currently reside on the device. At Blocks 320 and 330, the characteristics of the monitored transactions are captured and measured. User interaction data is generated from the monitored and measured transactions. It is important to note that Blocks 310-330 should not necessarily be interpreted as occurring sequentially in time. For instance, it is envisioned that measurements and data associated with the transactions will be captured as they are monitored, in real-time. Again, how this is accomplished is dependent upon the software probe. Measurement taking at Block 330 may occur in response to some triggering event or condition, such as the occurrence of a blocked or dropped call or upon the user initiating a call or redial.

In FIG. 4, the interaction between a communication device and the rest of the network is described. As in FIG. 3, Blocks 410-430 describe monitoring of

1 transactions to generate the user interaction data. At Block 440, this data is  
2 transmitted to the network. As previously described, this transmission may  
3 occur directly from the communication device to the network or it may occur  
4 via a collection communication device. The user interaction data will be  
5 transmitted to a server element of the network where it may be analyzed by a  
6 network operator, meaning someone interested in the network engineering  
7 metrics and/or user profile information contained within the user interaction  
8 data, to identify one or more network engineering problems at Block 450.  
9 These problems, once identified, may then be countered, as in Block 460.  
10 Reports based upon the identified network problems and/or steps taken to  
11 counter them may be generated at Block 470; it is understood that report  
12 generation may occur before or after Block 460. Such reports will have value  
13 to various functionalities of the network operator, such as engineering,  
14 customer service, operations, maintenance, etc.

15  
16 As discussed, the more data that is collected from communication devices  
17 throughout the network the better the statistical basis for identifying and  
18 improving network quality from the perspective of the network user. To this  
19 end, it is understood that Blocks 410-440 will likely be performed for multiple  
20 communication devices of the network. The user interaction data from  
21 multiple communication devices can then be aggregated in order that  
22 statistically significant information about the network is collected. The  
23 identification of network problems and any subsequent counter-measures  
24 enacted in response to them can thus be expected to be more efficient and  
25 efficacious.

26

1

2 Those of ordinary skill in the art will recognize that the present invention has  
3 been described in terms of exemplary embodiments. In particular, it should  
4 be noted that a number of spring plungers different from two may be used  
5 without departing from the spirit and scope of the present invention. It should  
6 also be noted that the gimbal system could employ one or three axes as well.

7

8 While the invention has been described in conjunction with specific  
9 embodiments, it is evident that many alternatives, modifications, permutations  
10 and variations will become apparent to those of ordinary skill in the art in light  
11 of the foregoing description. Accordingly, it is intended that the present  
12 invention embrace all such alternatives, modifications and variations as fall  
13 within the scope of the appended claims.

14

15 What is claimed is:

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